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Pollen in Hayfever*

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All true hayfever is caused by pollen. Now that this point is quite certain 'pollinosis' would be a more appropriate name for the malady, that is if one wishes to be strictly scientific and correct. But now that we all know that hayfever is not a fever and is not caused by hay there can be no harm in calling it hayfever. Indeed the term has the advantage of picturesqueness and falls into the same category as welsh rabbits, cow-catchers, and dog-tooth violets. Of course there are other substances which cause the symptoms of hayfever, such as orris root in face powder, box-wood sawdust of the jeweler, castor pumice used as fertilizer, or even ordinary wheat flour used in baking, but symptoms from these causes are by definition excluded and, anyway, they generally resemble asthma more closely than hayfever.

Since all true hayfever is due to pollen the malady follows the cycle of the seasons. First there is the early spring hayfever which comes, in the Torrey Club area and several hundred miles around in all landward directions, in the earliest spring, almost as soon as the frost leaves the ground. This is due to the early-flowering trees which take advantage of their leafless condition, perhaps also of the comparative scarcity of hungry insects, to scatter their wind-blown pollen. This is followed in May by the early summer type of hayfever which is called "rose cold," a practice which cannot be condoned because it sometimes leads the uninitiated to believe that roses have something to do with it. In reality it is caused almost entirely by grasses, helped a

* A second part of this paper, dealing with the structure of pollen grains will be published in the September-October number of Torreya.

little, perhaps, by plantain. Toward the end of July this type of hayfever gradually dies out as the common grasses begin to set their seed. Patients may even have comparative freedom from symptoms for two or three weeks, or until the middle of August when the third and worst hayfever season begins. This is of the type which is called "ragweed fever," and with justification because it is almost entirely due to the pollen of the ragweeds and their closest relatives. It goes on until all such weeds, dry up, as they often do toward the end of summer, or their flowering is stopped by an early frost.

These three seasons differ greatly in their relative importance. Early-spring hayfever is comparatively unimportant in the eastern part of the country, unimportant only because there are few cases, not because such are milder for they may be very severe. Among the earliest trees to flower in our region are the elms. Generally the first elm pollen may be detected in the air about the first of April, and very soon thereafter the elm-hayfever patients begin to have their troubles. Farther south where spring comes earlier the tree hayfever season also begins earlier. I once knew of an elm-hayfever patient who came north just ahead of the flowering of the southern elms, then returned south just ahead of the flowering of the northern elms. It was considered a very satisfactory way to spend a short vacation.

There are several other trees belonging to this very early period but of considerably less importance. Of these the willows begin to flower at about the same time as the elms, but they do not shed nearly so much pollen consequently they claim fewer victims and these are less affected, but their troubles may be greatly prolonged because there are so many kinds of willow flowering at different times that as soon as one kind has finished another takes its place. The season starts with the pussy willows as, for example, *Salix discolor* and *S. purpurea* flowering very early, generally in March much before the opening of the leaves. It is continued with the tree willows such as the crackle willow (*S. fragilis*) and the black willow (*S. nigra*) which flower either at the same time or just after the leaves unfold, continuing the season to nearly the end of May. Also belonging to the early season are the poplars. Though they shed excessive amounts of pollen, cases of hayfever from it are rare in the eastern states and generally of a mild character. The same is true of the

maples. They begin flowering in March or April with the silver maple, followed by the red, sugar, Norway, and three-leaved maples, ending up with the sycamore maple toward the end of May. Of all these, however, only the three-leaved maple is strictly wind pollinated, and it is the only one of which the pollen gets into the air in any great abundance. Perhaps this is why the maples claim relatively few victims during their exceptionally long flowering season.

The worst hayfever trees of all in the eastern states are the birches and oaks. They both flower in our region in May. The birches begin about the first of the month. Each species has only a short flowering period, lasting generally less than a week, but all together they extend through most of May. In our region the first to flower are the cultivated European birches, mostly *Betula alba*, followed by the native gray, yellow, and black birches (*B. populifolia*, *B. lutea* and *B. lenta*). Before the birches have finished flowering the oaks begin. All of the numerous species of oak that we have in our region flower at very nearly the same time so that the entire flowering period of the oaks lasts only about two weeks. This always occurs in May but varies with the season, sometimes beginning in the first week and sometimes the second. Both the birches and oaks are prolific pollen shedders. As a consequence their victims often suffer severely.

Before the tree hayfever season is over the late spring or early summer season begins, in our region about the first of May. This type of hayfever is almost entirely due to grasses and these, unlike the trees of the previous season, are so closely related that if a person is susceptible to the pollen of one he is likely to be susceptible to that of them all. The season is heralded in by the flowering of *sweet-vernal grass*. This is not quite the first grass to flower; the so-called annual blue grass (*Poa annua*) springs up from its roots of the previous season several weeks ahead of sweet-vernal grass, flowering sometimes even in March, but not until the sweet-vernal grass comes into flower do hayfever patients feel any discomfort from grass pollen. Toward the middle of May *June grass* and *orchard grass* begin to contribute their pollen to the air, and reach their maxima during the first week in June; these two grasses are accountable for nearly all the hayfever during the latter part of

May and the first part of June, after which they gradually go to seed. But before they have waned enough to permit much relief to hayfever sufferers *timothy* and *red top* take their place as pollen distributers. Starting during the last week in June, they reach their maxima early in July, begin to set their seed toward the middle of July and before the end of the month their pollen ceases to trouble the hayfever patient.

These five grasses, sweet-vernal grass, June grass, orchard grass, timothy and red top, probably account for nearly all the grass hayfever in the northeastern states, but there are a few others which, even though by comparison with these are of only secondary importance, deserve consideration. For example there is the red fescue which comes into flower at about the same time as June grass. It is a tough wiry little plant, unlike June grass, not at all particular where it grows; it is characteristic of dry sandy hills and impoverished soils. I have seen it in what appeared to be nothing but ashes seeming to rejoice in the total absence of competition. Then there is meadow fescue which is somewhat similar in appearance but grows only in rich moist meadows. Both these and some of the other species of fescue are prolific pollen shedders and would undoubtedly rank among the grasses of first importance in hayfever if they were more abundant. To this list should also be added quack grass, abundant enough it is true, but only a weak pollen shedder, the darnel and perennial rye grass which rank high as pollen producers but in most places not abundant enough to be very important. And there are many others still less important for, as we have seen, grasses are all grasses to the hayfever patient, their importance being conditioned by their abundance and their propensities for producing pollen. Each one helps the other in making life miserable for the hayfever sufferer and so much mixed up are they that the victim is at a loss to tell just where to put the blame.

English plantain (*Plantago lanceolata*) is a lone invader among hayfever plants. It sheds large quantities of light pollen during the latter half of May and most of June, continuing right to the end of summer in reduced amounts. Its pollen does not interreact with that of the grasses. That is to say, a patient may be highly sensitive to the pollen of grasses and not respond in the slightest degree to that of plantain, and vice versa. English

plantain has several relatives which are common weeds, for example, Rugel's plantain and common plantain (*P. Rugelli* and *P. major*) but these are far too chary with their pollen to ever be seriously considered as causes of hayfever no matter how common the plants themselves may be. Like the trees, English plantain claims but few victims but those it does are likely to suffer severely.

Most of the grasses mentioned above, all the worst ones, are grasses of agriculture, and plantain is a weed of agriculture, and so it has always been and always will be that man wherever he invades new territory takes his hayfever with him. In warm countries it is Bermuda grass, the worst hayfever grass throughout the south, and in dry places it is Johnson grass, a particularly bad hayfever plant throughout much of our middle west.

In the northeastern states after the flowering of timothy and red top there is relatively little pollen in the air and as the season advances hayfever patients may even enjoy comparative freedom from symptoms until the middle of August when comes the late-summer hayfever period. This begins in the Torrey club area almost exactly on the fifteenth of August, the cause, the tall and short ragweeds. The first flowers of tall ragweed open on about the first of August and the first of the short a week later, but not until the fifteenth do their combined efforts produce sufficient concentration of pollen to cause serious inconvenience to hayfever sufferers. The pollen is very light and of an extremely buoyant character so that as the plants continue to grow the air becomes more and more heavily charged with pollen. It has been estimated that over New York City the air carries several tons of pollen at the height of the season which occurs during the last week in August and the first in September. From this peak the pollen load of the air gradually declines as the ragweed plants go to seed but during September, before the ragweed pollen in the air has tapered off enough to bring much relief to the hayfever sufferer, the cockleburs begin to make their presence felt, for, on account of their close relationship to the ragweeds, their pollen is essentially the same in its toxicity to hayfever patients. At this time also the goldenrods offer their contribution. It is not much and does not usually count at all, except on gusty days, for its pollen does not have the buoyant character of that of ragweed, but it does have a

similar toxicity and sometimes adds a little to the troubles of the hayfever sufferer. Still, in spite of these additions, the load of toxic pollen in the air gradually tapers off, but does not actually reach zero until well into October, unless halted by an early frost.

In California and the southwestern states there is the western ragweed (*Ambrosia psilostachya*) similar in appearance to the eastern short ragweed. In the South, eastern Texas, and the lower Mississippi valley, is the western giant ragweed (*A. aptera*), and in the mid-western prairie states, Louisiana and eastern Texas, is the southern ragweed (*A. bidentata*). In Florida there is the coast ragweed (*A. hispida*) which, however, appears to be a negligible factor in hayfever. It is safe to say that not a state in the Union is entirely free of ragweeds. Besides this the ragweeds have a number of very close relatives which are essentially the same in their effects on hayfever patients. There is the genus called the false ragweeds (*Franseria*) so close to the true ragweeds in appearance that it is difficult to tell them apart. Two of these are counted as very bad hayfever plants; the bur ragweed (*F. acanthocarpa*) is a common weed almost throughout the Rocky Mountain states and westward to the coast range, and the slender ragweed (*F. tenuifolia*) is characteristic of the arid plains of our southwestern states from Kansas and Oklahoma to southern California. Still another genus, not quite so closely related to the ragweeds yet close enough to be nearly the same thing as far as the hayfever patient is concerned, is the genus of marsh elders (*Iva*). In the east we have a marsh elder common in tidal marshes along the Atlantic coast. In the Torrey Club area it is known as *Iva oraria*. It extends from Massachussets southward along the Atlantic coast. Somewhere in Virginia its name is changed and from there it extends on as *Iva frutescens* around Florida and along the Gulf coast. It causes little trouble to hayfever sufferers, none outside of the immediate vicinity of the tidal marshes, but its pollen reacts almost as violently as that of ragweed. The rough marsh elder is a real hayfever plant of our midwestern prairie states from Iowa and Nebraska southward, and the poverty weed (*I. axillaris*) is often a factor of importance throughout much of the huge region from southern Manitoba to Oklahoma and westward almost to the Pacific coast. Still another member of

this group of ragweed relatives is the prairie ragweed or "Burweedmarsh elder." Its correct name is *Cyclachaena xanthiifolia*. Throughout much of its range which extends from Michigan to Washington and southward to Oklahoma and New Mexico, it is as important a cause of hayfever as any of the ragweeds.

The ragweeds and their relatives constitute one of the 14 tribes of the composite family, the tribe most closely related to the sunflower tribe. The connection between these two tribes has been clearly established by George Bentham, the great English botanist of last century and the greatest student of the Compositae of all time. The complete interaction which allergists have found between the pollen of the two tribes, and the forms of their pollen grains proclaim their relationship. In fact the morphology of their pollen grains shows that the ragweed tribe may be regarded as a group of wind-pollinated derivatives of the sunflower tribe. In spite of this there is a tendency among modern botanists to treat the ragweed tribe as a separate family, misled, perhaps, by the extreme modification in outward appearance that these plants have sustained in response to wind pollination. This treatment is misleading to allergists because it removes the implication that the other members of the composite family should be regarded as potential hayfever plants, an implication that is abundantly sustained by experience.

Another large group of Compositae—but in another tribe, the Anthemideae,—is the group of sage brushes, wormwoods and mugworts (*Artemisia*). All of the many species of this huge genus appear capable of producing hayfever providing they are abundant enough and their pollen sufficiently copious. In the eastern states the few species of *Artemisia* which are found can never be counted as more than minor contributary causes of hayfever, but in the Prairie states and the Great Basin area, where several species are much more abundant, the sage brushes, mugworts and wormwoods are frequently primary causes of hayfever.

We have seen that all of the hayfever plants of this latter season belong to the composite family. As with the grasses, the ability to cause hayfever would seem therefore to be here a family character. But what of the other Compositae, the asters, daisies, coreopsis, thistle, and dandelion? We know that they

do not cause hayfever. The answer is found in their mode of pollination. There are two ways in which the majority of flowering plants are pollinated, viz. by insects (entomophily) and by wind (anemophily). Plants which are insect pollinated and perfectly adapted to this mode of pollination cannot cause hayfever. Thus the orchids, milkweeds, sweet peas, and many others of the more highly specialized flowers produce their pollen in such a way that it remains in the flowers until removed by the insect which is to carry it to another flower. But by no means all insect pollinated flowers are so perfectly adapted to entomophily as orchids, milkweeds and sweet peas. All stages of imperfection in this adaptation are found. For example, if a flowering branch of goldenrod is placed in water in the house, after a few days pollen will be found scattered on the table beneath the flowers. Out-of-doors this pollen, if not carried away by insects, is blown away and even at times may become a menace to hayfever sufferers; certainly it can easily be detected on pollen slides far from the flowering goldenrods. An oustanding example of imperfect entomophily is found in the willows. Some of the standard manuals of botany state that willows are wind pollinated others that they are insect pollinated. Both are right; willow flowers are brightly colored, sweet scented, provided with nectaries, and attract to themselves many insects which effectively carry their pollen from flower to flower; so they are insect pollinated. On the other hand their stamens are exserted and their pollen is not very sticky so that, if it is not removed by insects, it is easily blown away by the wind. Indeed willow pollen is often caught on pollen slides several miles away from flowering willow trees; so they are wind pollinated. Another example of such a dual method of pollination is found in the red maple which appears to be about equally wind and insect pollinated. The maples are not all alike in this respect. In fact the several species comprise a nicely graded series ranging from the Norway, Sycamore, and striped maples which are entirely entomophilous, through the silver, red and sugar maples which are both insect and wind pollinated, to the three-leaved maple (*Acer Negundo*) which is entirely anemophilous. As we pass along this series we note that the flowers become less showy and attractive to insects but produce more pollen and of a less sticky character. The flowers of the

three-leaved maple are drab colored and of no interest to insects but produce enormously more pollen than the bright yellow flowers of the Norway maple which are the delight of honey-gathering insects.

Anemophilous flowers may generally be recognized as such by their lack of attractiveness to insects. Thus the poplars, while closely related to the willows, are entirely anemophilous. Their flowers lack the sweet scent, yellow color and nectar of the willows, and are left severely alone by flower-visiting insects, but they produce enormously more pollen. The oaks, elms, birches, and, in fact, most of our forest trees are of this character. It is only among such plants with drab inconspicuous flowers that one need look for the real causes of hayfever.

It does not necessarily follow that all wind pollinated plants cause hayfever. This characteristic belongs only to relatively few families. Besides those already mentioned the family of the chenopods possess it to a degree; for example. Russian thistle is an important hayfever plant throughout much of the western part of the country. The closely related family of the amaranths also possess it; for example, the western water hemp in Oklahoma and neighboring states. The Knot-weed family possess it to a still lesser degree; for example, cases of hayfever from such wind-pollinated members as the docks have been recorded. On the other hand the cattails are among the most prolific pollen shedders, yet, I believe, no authentic cases of cattail hayfever have been recorded. Pine is the most universally abundant pollen in the atmosphere yet no cases of pine hayfever have ever been recorded. In fact none of the conifers or other gymnosperms, except Mexican cedar, seem to be capable of producing hayfever in spite of the fact that they are all outstanding practitioners of anemophily. Mexican cedar is a curious exception. It grows on the limestone hills of Texas and, flowering in December and January, is said to cause a severe type of winter hayfever in the city of Austin. It is a juniper (*Juniperus mexicana*), yet the several other members of the genus which are common almost throughout North America seem to be harmless to hayfever patients. In order to be a real cause of hayfever pollen must possess three characters: it must be buoyant and easily distributed in the air; it must be abundant; and it must be toxic.

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EXPLANATION OF PLATE I

Beginning at the top and following down to the bottom the grains are named and their diameters given in microns.

Top, left—Timothy, *Phleum pratense* L., 28.5

Top, center—Plantain, *Plantago lanceolata* L., 30

Top, right—Birch, *Betula alba* L., 26, polar view, drawn as if partly cut away to show optical section

Second, left—Oak, *Quercus alba* L., 34.2, polar view

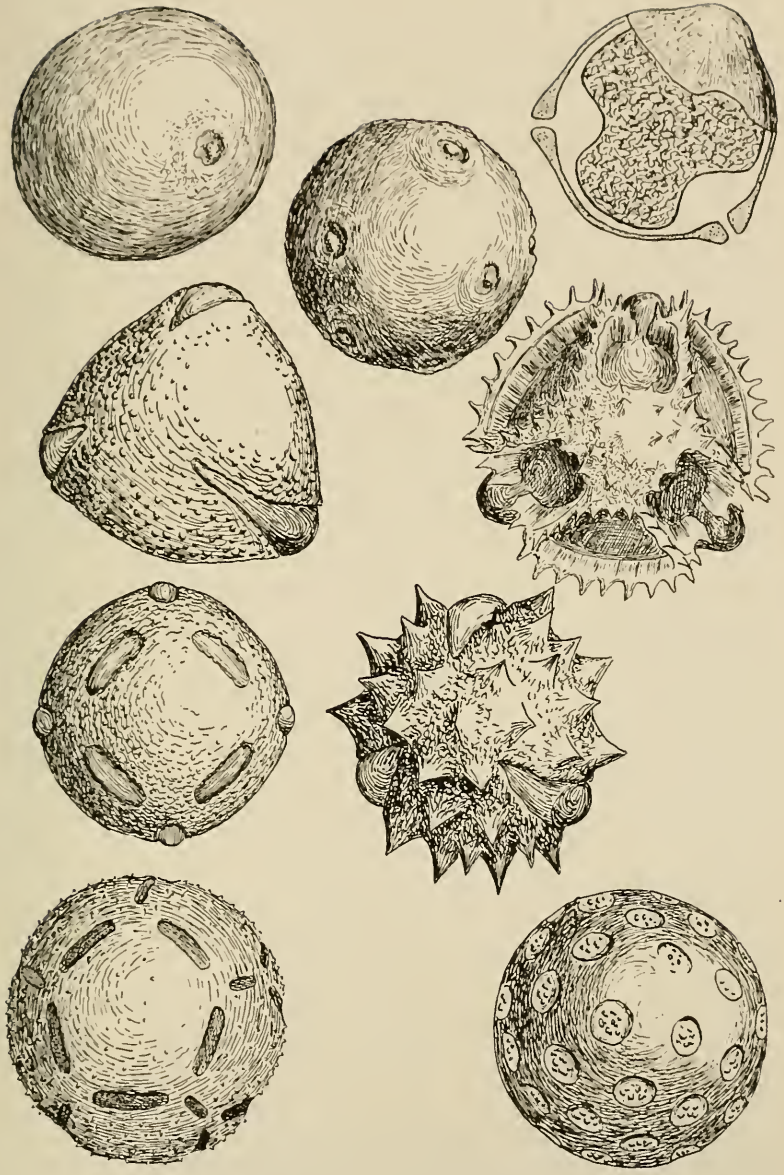
Second, right—Dandelion, *Taraxacum officinale* Weber, 34.2, polar view

Third, left—Carpet weed, *Mollugo verticillata* L., 32.3, showing four, and the ends of four more, of its twelve furrows

Third, right—Goldenrod, *Solidago speciosa* Nutt., 22

Bottom, left—Portulaca, *Portulaca grandiflora* Hook., 80.6

Bottom, right—Russian thistle, *Salsola Pestifer* A. Nels., 27.5



Wodehouse: Pollen Plate I